

RULE BASED REASONING AND CASE BASED REASONING TECHNIQUES FOR JUVENILE DELINQUENCY LEGAL REASONING MODEL

**Sharifah Lailee Syed-Abdullah, Hidayah Daniyal, Rusnadewi A.Rashid,
Sarina M Noor, Noorzila Sharif**

Universiti Teknologi MARA Perlis, Malaysia, shlailee@perlis.uitm.edu.my

ABSTRACT. The ability to extract and analyse correct precedent cases and court orders is critical because recommending correct court orders is of utmost importance in ensuring that every case is trialed accordingly. Currently, precedent cases and court orders are searched and extracted manually thus, causing backlog in juvenile delinquency trials. This paper discusses the development of a Juvenile Delinquency Legal Reasoning (JDLRes) Model that has the ability to imitate human reasoning in assisting probation officer to recommend court orders for juvenile delinquency cases. Rule-based reasoning (RBR) and case-based reasoning (CBR) are the techniques used to add consistency with flexibility when recommending court orders for new cases. The simulation model was developed to validate JDLRes Model. The comparison results between the model and human expert reveal the existence of generality aspect in the legal domain. Future work requires the study of precedent cases and court orders in different states in Malaysia.

Keywords: rule based reasoning, case based reasoning, juvenile delinquency, k-nearest neighbor.

INTRODUCTION

In the legal domain, reliable data refers to precedent cases and court orders. Precedent cases are previous juvenile delinquency cases committed by the same or different juvenile. Probation officers refer and analyse precedent cases before recommending court orders for new cases. The ability to extract and analyse correct precedent cases and court orders is critical because meting out the correct court orders is of utmost importance in ensuring that every case is trialed accordingly. However, in juvenile delinquency context in Malaysia, precedent cases and related court orders are searched, accessed and analysed manually. Without a reliable technique to access and analyse precedent cases and court orders efficiently and intelligently, probation officers need more time to complete their research and frequently, this leads to backlog in juvenile cases trials. In addition, without specific and effective technique to ensure consistency with flexibility in recommending court orders, discrimination in the decision making process may occur. This leads to frustration and dissatisfaction amongst individuals. Consequently, there is a need for an effective technique that will ensure fairness in the decision making process. In this world, where majority of the population are IT literated, people are demanding for the appropriate solution to solve critical situations in a complex system. This paper discusses the development of a Juvenile Delinquency Legal Reasoning (JDLRes)

Model that has the ability to intelligently search and extract precedent cases and related court orders for juvenile delinquency cases.

The paper is organized as follows; Section 2 describes the research background to this study. Section 3 discussed the methodology used to complete the study, Section 4 presents the results and discussion of the study and lastly Section 5 defines the future work of the study.

RESEARCH BACKGROUND

Law complexities challenge AI researchers because law has its own reasoning process based on *stare decisis* principle where judges are obliged to respect the precedents cases established by prior decisions. Therefore legal knowledge such as precedent cases and law rules must be accessible and relatively well structured, codified and indexed to enable AI researchers to venture into legal domain (Raman & Palanissamy, 2008). A review by Prentzas (Prentzas & Hatzilygeroudis, 2007) indicates that development of rule-based applications started since late 1960s with the creation of DENDRAL in organic chemistry domain. In the medical domain, MYCIN is the most significant early rule-based expert system developed by Shortliffe in 1976 (Pandey & Mishra, 2009). MYCIN is the first system that used knowledge separation and heuristic nature in knowledge representation. In the legal domain, PADUA was designed as arguments debating agent using rules (Wardeh, Bench-Capon, & Coenen, 2009). SHYSTER-MYCIN is a hybrid legal expert system created by Thomas O'Callaghan (O'Callaghan, Popple, & McCreath, 2003) that combined a case-based legal expert system (SHYSTER) with a rule-based expert system (MYCIN). SHYSTER used analogy to reason with cases while MYCIN reasoned with the provisions of legal Acts only. The construction of SHYSTER-MYCIN focused on creating and evaluating its legal reasoning model and Australian copyright law has used this system as the tested domain due to the simplicity of knowledge representation structure in SHYSTER. Early work by (Sharifah-Lailee & Rahman, 2010) on juvenile delinquency in northern Malaysia generate a Juvenile Legal Assistance, a prototype to assist new probation officers who has no experience in juvenile delinquencies cases. However, the prototype applied rule-based technique only and required further upgrading. One of the challenges in legal expert system is to develop a knowledge system model for intelligent retrieval of legal cases. The expert system should facilitates the process of defining precedents before judicial opinions are given.

METHODOLOGY

The methodology for this study consists of six phases which are data and knowledge acquisition, data and knowledge analysis, construction of rule based reasoning and case based reasoning structure, development of the juvenile delinquency legal reasoning model, and lastly, the validation of the model.

Data and Knowledge Acquisition

Data acquisition was done by reviewing documents and interviewing domain experts. The documents reviewed were Juvenile Registration Logbook, Juvenile Probation Reports and Child Act 2001 Legislation Statutes. Reviewing the Registration Logbook gives details of the activities carried out by the probation officers handling the cases. From the Juvenile Probation Reports, only decided juvenile cases were extracted. Decided juvenile cases refer to cases that have been processed and have court orders recorded in the file. Due to limited access of confidential data, ethical considerations and time constraints for collecting the data, a set of questionnaires was created for extracting relevant data from this report. Lastly, the review of the Child Act 2001 Legislation Statutes shows that assistance from a legal expert must be sought in order to have an indepth understanding of the juvenile delinquency cases. Child Act 2001 is an Act to consolidate and amend the laws relating to the care, protection and rehabilitation

of children in Malaysia. The second method of knowledge acquisition is interview sessions with the probation officer to understand and identify the complete procedure for processing juvenile cases.

Data and Knowledge Analysis

The second phase of the methodology is data and knowledge analysis which focused on analysing the three types of document and the interview transcripts. First, to determine the relationship between offences and related court orders, decision tree was applied. Second, to examine decided juvenile cases, content analysis was used. The analysis focused on understanding the relationship between personal, home and parental variables and committed offences variables. This information is important because probation officers are needed to produce the recommended court orders.

Rules based Reasoning

In this study, rules-based reasoning involves a straightforward transformation process of legal statute to rule form. The purpose of this transformation is to identify and select the rules for offences committed. There are 135 sections in Child Act 2001, however, analysis of the Juvenile Probation Report shows that only Section 46, 91, 93 and 98 are referred and 21 sets of rule were constructed. An example of the rule constructed is shown in Figure 1.

<p>IF</p> <p>(Juvenile is children beyond control)</p> <p>THEN</p> <p>The court make the following orders:</p> <p>Sect. 46(2)(aa) sent to an approved school, place of refuge, probation hostels or centres</p> <p>Sect. 46(2)(bb) placed for such period not exceeding three years under supervision of probation officer or appointed person by Court</p>

Figure 1. Example of the rule constructed from Child Act 2001

Case-based Reasoning

Case-based reasoning was conducted by defining the facts of cases. Facts of a case refer to the information belonging to a juvenile case, which are personal, home, parental and juvenile delinquency data. The facts of a case determine the new case's relationship with the precedent cases thus the recommended court orders. Each case was further analysed to determine the similarity index of the new case to precedent cases. To determine similarity between cases, Hamming and Manhattan equations were used. Then *k*-nearest Neighbour Classification (*k*NN) algorithm was used to define the closest relationship and identify the relevancy between precedent cases to the new case.

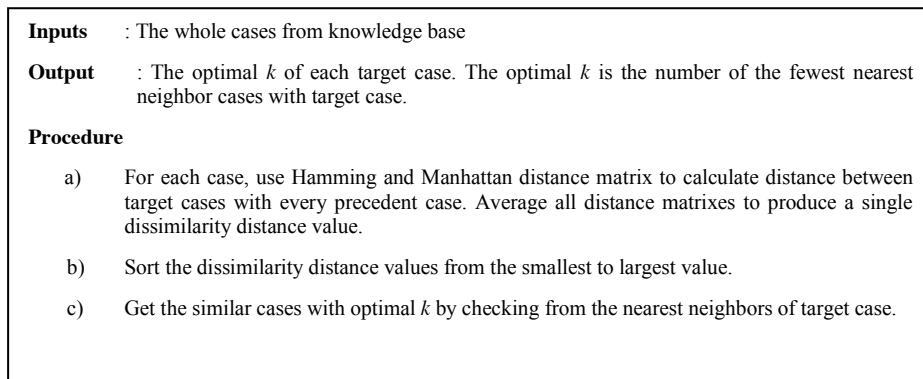


Figure 2. Case based algorithm for JDRES model

Model Development (JDLRes)

The Juvenile Delinquency Legal Reasoning (JDLRes) model was designed based on rule-based reasoning and case-based reasoning techniques. The model defines how the legal statutes rules and past juvenile cases were analysed and computed to produce the recommended court orders. Then, the analysed rules are stored in the rule knowledge base, where a rule inference engine was used to extract the rules. A forward chaining technique was used as inference mechanism to search and extract the related court orders for specific offences. The case knowledge base consists of completed precedent juvenile cases and a case reasoning engine was used to extract similar precedent cases. This engine used three algorithms to calculate the similarity between new cases and precedent cases. First, Hamming algorithm was used to calculate the nominal data while Manhattan algorithm was used to calculate nominal and continuous data. Then these values were normalized using similarity metric. Lastly, the third algorithm k -nearest neighbour algorithm was used to classify similar precedent cases. The extracted rules from Rule Knowledge base and similar precedent cases from Case Knowledge base were combined to produce the recommended court orders for a specific juvenile case. The Juvenile Delinquency Legal Reasoning (JDLRes) model is illustrated in Figure 3.

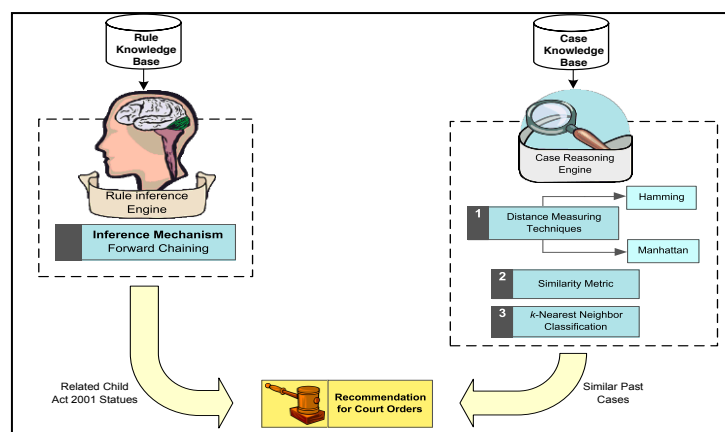


Figure 3. Juvenile Delinquency Legal Reasoning (JDLRes) model

Model Validation

A computer simulation program was developed to validate the JDLRes Model. The computer simulation used 21 sets of rule which are stored in rule knowledge base while all precedent cases are stored in case knowledge base. To ensure that the simulation model is a real representation of the JDLRes Model, calibration of the model was conducted. Calibration procedure is an iterative process of comparing the simulation model to the JDLRes Model. Any discrepancies between the simulation model and JDLRes Model were resolved through the repetitive process of comparing rules and cases, and upgrading the algorithm (Sharifah-Lailee, Hidayah, Rusnadewi, Noorzila, & Noorazizah, 2013). The validation was made by analysing the ability of the computer simulation model to produce the similar result as the human expert. A probation officer was chosen as an expert to review the model. Screen shots of the simulation model is shown in Figure 4.

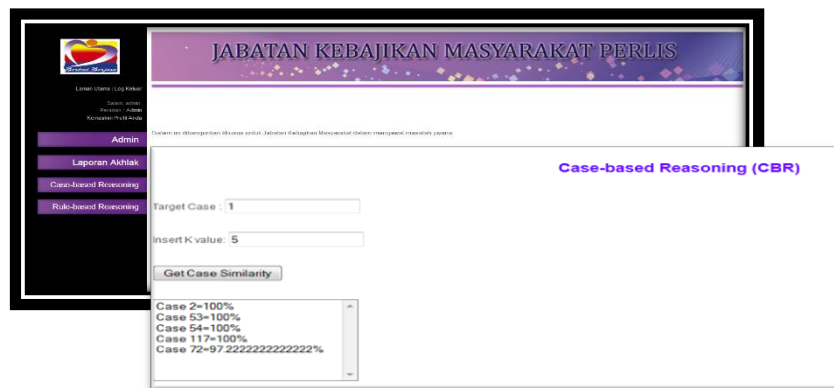


Figure 4. Screen shots of JDLRes

RESULTS

Example of cases retrieved is shown in Table 1. The value of k refers to the number of precedent cases, an officer would like to analyse. In this example, k is 5 which informed the model to extract 5 most similar precedent cases to the current case. The most similar cases are case 2, 53, 54, 117 and 72, which are retrieved based on their ranked similarity percentage. The significance of this model lies in the ability to extract the most similar precedent cases quickly thus allowing a probation officer to analyse, justify and recommend the most appropriate court order. The extracted precedent cases contained facts that are similar to the new case thus allowing ample time for legal officers to properly analyse and reason before recommending court order for the new case.

Table 1. Target case and retrieved cases information

CaseNo	Target Case	2	53	54	117	72
Similarity Percentage	-	100%	100%	100%	100%	97%
Age	17	17	17	17	18	17
Gender	Male	Male	Male	Male	Male	Male
Race	Malay	Malay	Malay	Malay	Malay	Malay
Custody Type	With parents	With parents	With parents	With parents	With parents	With mother
Residence Type	'Rumah Kampung'	'Rumah Kampung'	'Rumah Kampung'	'Rumah Kampung'	'Rumah Kampung'	'Rumah Kampung'
Parent Occupation	Private Sector	Private Sector	Private Sector	Private Sector	Government Sector	Private Sector

Parent Education	Secondary	Secondary	Secondary	Secondary	Secondary	Secondary
Parent Income	RM1001- RM2000	RM1001- RM2000	RM1001- RM2000	RM1001- RM2000	RM601- RM1000	RM1001- RM2000
Offence	Under Poison Act 1952	Under Poison Act 1952	Under Poison Act 1952	Under Poison Act 1952	Personal injury	Child beyond control
Orders	-	Sect 91(1)(b) Bond of good behaviour Sect 93(1)(a) Report at JKM	Sect 91(1)(b) Bond of good behaviour Sect 93(1)(a) Report at JKM	Sect 91(1)(b) Bond of good behaviour Sect 93(1)(a) Report at JKM	Sect 91(1)(b) Bond of good behaviour Sect 93(1)(a) Report at JKM	Sect. 46(2) (aa) Sent to the hostel Sect. 46(2)(bb) Supervision of JKM officer

DISCUSSION

The law tradition is built on the principle of Stare Decisi (stand by decided matters) which require court to refer to past cases as guidance before deciding on new cases. The use of precedent cases provides predictability and fairness in the law as legal officers are require to match facts and rules of precedent cases to a new case. However, matching of facts and rules is a not a direct and objective process because often the facts and rules do not match. The ability to consistently refer to the various rules in Child Acts 2001 yet it is flexible enough to extract most similar precedent cases adds credential to the reasoning made by legal officers when recommending court orders for a new case. This is the contribution of JDLRes Model in ensuring that fairness is practice in the juvenile court. Fairness is of utmost importance as the existence of generality aspects in the legal domain demand legal officers to research extensively all available precedent cases.

In this study, it was discovered that different states in Malaysia apply different court orders in juvenile delinquency cases. The differences in the penalty used in different states are due to two reasons. First, the number of offences in both states varies. For example, the long term penalty such as interactive workshop which requires continuous observations is imposed on offenders for reckless and dangerous driving in Perlis. Since the number of juvenile cases is small, this penalty is easy to monitor. However, for the same offence in Kedah, the penalty which does not require long term observation is chosen because the increasing number of offences leads to the difficulty in monitoring the execution of interactive workshops. The second reason is the seriousness of an offence in both states varies according to probation officers' perception. For example, there is no serious offence committed in Perlis such as rape and threat of death as occurred in Kedah. Therefore, the offence if committed in Perlis is the most serious offence and deserves the most severe penalty. Compared to Kedah, the same offence are considered as a common offence and therefore, should not be treated as serious since there are other more serious offences committed in Kedah. Therefore the ability of the model to extract precedent cases that are similar to the new cases and inform legal officer of the percentage similarity will ensure consistency of precedent cases but allow officer the flexibility of recommending court orders. Flexibility is important in the law domain as court orders for first timer should be to educate but for repeated offenders it must reflects punishments.

CONCLUSION AND FUTURE WORK

The strength of JDLRES Model lies in its ability to correctly define and extract precedent cases and related court orders. The ability of the JDRES model to successfully achieved 60% accuracy shows that this model will be able reduce backlog in juvenile case trials. The factor that contributed to the lower accuracy level is the generality aspect in the legal domain. Two elements that contribute to the generality aspect are the different level of seriousness for dif-

ferent states in juvenile cases and the number of offences committed by juveniles in different states in Malaysia. Therefore, future work on the upgrading of JDLRes Model requires the studies of precedent cases and court orders in all states in Malaysia. The data collected must cover all cases that have been committed and the reports must include intelligent comparison of all offences and court orders in different district of each state. It is important that future work includes clustering of offences and the districts where the offences were committed. It is hoped that this initial study will carve a path in the development of a more intelligent model that are able to intelligently reasons the rules and precedent cases and able to accommodate the generality aspect existed in the legal domain.

ACKNOWLEDGEMENT:

This research is funded by Ministry of Science, Technology and Innovation (MOSTI), Malaysia through Science Fund [File No: 100-RMI/SF 16/6/2 (6/2015)]. We are grateful to Universiti Teknologi MARA (UiTM) for the continuous support given to the research.

REFERENCES

- O' Callaghan, T. A., Popple, J., & McCreath, E., (2003), SHYSTER-MYCIN: A Hybrid of legal expert system. *Proceedings of the 9th International Conference on Artificial Intelligence and Law*, 103-104. doi: 10.1145/1047788.104814
- Pandey, B., & Mishra, R. B. ((2009). Knowledge and Intelligent computing system in medicine. *Computers in Biology and Medicine*, 39(3), 215-230.
- Prentaz, J., & Hatzilygeroudis, I., (2007). Categorizing approaches combining rule-based reasoning and case-based reasoning. *Expert Systems*, 24(2), 97-122. doi: 10.1111/j. 1468-0394.2007.00423.x
- Raman, V., & Palanissamy, A.(2008). Computer Aided Legal Support System: An initial framework for retrieving legal cases by case reasoning approach. *International Conference on Innovations in Information Technology (IIT)*, 317-321.
- Sharifah-Lailee, S. A., Hidayah, D., Rusnadewi, A. R., Noorzila, S., & Noorazizah S. (2013). Conceptual Framework for Recommending Juvenile Delinquency Court Orders. Paper presented at the *International Conference of Soft Computing and Computational Mathematics*.
- Sharifah-Lailee, S. A., & Norhayaty, A.R.(2010). A Prototype of Recommendation System for Juvenile Offenders Using Rule-based Technique, *Technical Report*, Universiti Teknologi MARA Perlis.
- Wardeh, M., Bench-Capon, T., & Coenen, F. (2009). PADUA: A protocol for argumentation dialogue using association rules. *Artificial Intelligence and Law*, 17(3), 183-215. doi: 101007/s10506-009-9078-8.